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Monetary and Real Causes of Investment Booms and Declines

by

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WP 1020-78 Sept. 1978

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INSTITUTE OF TECHNOLOGY
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Nathaniel J. Mass
Assistant Professor of Management
Massachusetts Institute of Technology
Cambridge, Massachusetts

September 6, 1978

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I. Introduction

The 1900's have marked two major investment booms in the United States. The first occurred in the 1920's, when according to Gordon (1974), expenditures for producer and consumer durables comprised a larger fraction of GNP than during any period prior to World War I. This boom was followed by the Great Depression of the 1930's, which was particularly characterized by the collapse of the new capital formation. The second investment surge occurred in the 1950's and early 60's. This boom has been followed in the early 1970's by a period of abnormally lagging investment.

This glance at economic history suggests several important questions. First, what are the forces that periodically produce major investment booms? Second, what are the forces that underlie sharp investment declines? The third question, closely related to the second, is how do the circumstances of an investment boom lead into subsequent decline? Keynes (1937a) specifically addressed this third question in noting that "increased demand for money resulting from an increase in activity has a backwash which tends to raise the rate of interest, and this is, indeed, the significant element in my theory of why booms carry within them the seeds of their own destruction." The third question links the first two because an adequate theory of investment booms and decline must explain not just the boom phase or the decline but also the transition between the two.

The economics literature embodies two main schools of thought on causes of investment booms and declines. The accelerator theory

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originated with Clark (1917) and focuses on real variables. According to the accelerator theory, rising demand for consumer goods evokes higher investment for replacement of adequate capital plant to meet sales. Moreover, rising sales trigger investment expenditures for expansion of capacity. According to the theory, investment demand for expansion depends on the rate of growth of final demand, and hence rising investment requires an accelerating growth of final demand. Samuelson (1939) expanded the accelerator theory by coupling it with the multiplier. In the multiplier-accelerator model, rising investment increases national income and thereby augments final demand. However, with a marginal propensity to consume of less than 1, final demand rises by less than the increase in investment. The declining rate of increase in final demand eventually lowers investment and thereby reverses the growth in income. Therefore, acccording to the multiplier-accelerator theory, investment downturns are brought about by either absolute declines, or even slackening growth, in consumption expenditures.

The monetarist theory emphasizes monetary rather than real variables as dominant causes of investment fluctuations. The monetarist position is best stated by Friedman and Schwartz (1963a, 1963b) and Friedman and Meiselman (1963). Friedman and Schwartz (1963a) identify a strong historical correlation between changes in the level of income and changes in the size of the money stock. They reject as unlikely the possibility that the correlation is due to coincidence. Further, they reject the possibility that changes in money stock are caused by shifts in demand for money and credit on the grounds that the stock of money is an autonomous variable controlled by the Federal Reserve. They

conclude, therefore, that changes in money stock underlie shifts in income.

Friedman and Schwartz note that the 1920's marked the first conscious attempt to use central bank powers to promote internal economic stability. They thus attribute the rapid economic growth and investment upsurge of the 1920's to steady monetary expansion. In a similar vein, Friedman and Schwartz attribute the severity of the contraction following 1929 to a one-third reduction in the stock of money between August 1929 and March 1933. They conclude:

> The contraction is in fact a tragic testimonial to monetary forces...different and feasible actions by the monetary authorities could have prevented the decline in the stock of money--indeed could have produced almost any desired increase in the money stock...it is hardly conceivable that money income could have declined by over one-half and prices by over one-third in the course of four years if there had been no decline in the stock of money.

In the literature, the accelerator and monetarist theories of booms and declines are not just competitive but almost mutually exclusive. Temin (1976) contrasts a "money hypothesis" and "spending hypothesis" of the Great Depression of the 1930's. Temin argues that Friedman and Schwartz show "almost complete indifference to income determination" in their narrative of the depression. On the other hand, the spending hypothesis omits the money stock as a causative factor:

> Instead, in parallel with the procedure adopted by Friedman and Schwartz, it assumes the validity of the "spending hypothesis" and leads toward the construction of a story on that basis...If investment is determined by a variety of factors other than the supply of money, the level of

> income will be, too. Therefore, [the spending hypothesis] cannot test the money hypothesis. The causes of the depression are sure to be found in the behavior of investment, not in the supply of money.

The mutual insularity of the monetary and spending hypotheses can be seen in the fact that the spending hypothesis contains no direct influence of money stock on transactions, while in the monetary hypothesis it is the dominant or even sole influence. Thus, in a recent symposium, Anna Schwartz (1976) notes that the MPS model "does not even contain the explanatory variables that [monetarists] deem important." Gould and Nelson (1974) and Pesek (1976) argue that modern-day monetarists attribute a dominant role to money but they assume that velocity is a stable function of other variables rather than absolutely fixed.

This paper attempts an initial integration of the money and spending hypotheses of investment booms and declines. An investment function is developed to interrelate real and monetary variables. In the model, investment is influenced by real variables (such as volume of sales), by relative prices of labor and capital equipment, and by money stock. Money enters through a liquidity constraint on investment, whereby inadequate liquidity limits investment expenditure while abundant liquidity encourages investment. The combined investment function is simulated to study investment behavior. The analysis leads to three major conclusions:

1. Changes in real variables can induce sustained investment booms that eventually give way to over-expansion of capital production

capacity and subsequent decline in investment; the same forces that reinforce the investment upturn reverse their influence once production capacity becomes excess, and promote decline in capital investment.

2. Changes in relative prices of labor and capital work in the same direction as the real variables to accentuate either investment booms or declines; such influence of relative prices lies between the "real" emphasis of the accelerator theory and the money stock emphasis of the monetarist theory.

3. An expanding money stock is indispensable to supporting an ongoing investment boom, and more generally, Federal Reserve policies regarding money supply can exert important influences on long-term investment behavior. However, contraction of money supply is not a necessary or even prime cause of investment downturns.

These conclusions are developed in the text, and the analysis is related to results of Friedman and Schwartz and of Temin, and to recent work of Minsky on the "Financial Instability Hypothesis."

II. FORCES SUSTAINING INVESTMENT BOOMS

This section describes forces that sustain prolonged investment booms such as that of the 1920's and of the 1950's and early 1960's. The discussion is divided into investment incentives that derive from:

1. Real forces
2. Shifts in relative prices
3. Monetary variables

The Model description in Section II draws heavily on Mass (1978). Section III subsequently combines these elements into a simulation model to isolate the impacts of the real and monetary variables in creating investment booms and declines.

II.A. Impact of Real Variables

One set of pressures that can reinforce capital expansion derives from determinants of desired output rate in capital sectors. In the accelerator model, output of capital goods is geared to meet average orders or sales. In the simplest form of the accelerator, capital-output ratio is assumed to be fixed by economic or technological factors, so that desired capital stock is a multiple of average orders or sales of capital goods. (See Chenery (1952), Koyck (1954), and Kuh (1965) for examples.) In more recent investment work, the capital-output ratio is itself taken to be a variable that depends on output prices and prices of factors of

production. (See Jorgenson and Siebert (1968)) and Bischoff (1971) for examples). In either model, investment is viewed as part of the stock adjustment process that moves capital stock toward its desired level. Under the simplest assumption of a one-period adjustment in capital stock, investment responds to the difference between desired capital at the present time and desired capital in the previous period, the latter equal to actual capital stock at the present time, so that investment depends only on the rate of change of sales.

The accelerator model in either form (with fixed or variable capital output ratio) is limited in describing the circumstances of an investment boom by assuming that output of capital goods is geared only to past sales. For example, during a period of expanding sales, production of capital goods will initially lag orders and sales, but will later need to rise above both to replenish output inventories and to reduce to an acceptable level a high order backlog that builds when production capactiy is below orders. Thus, realistic portrayal of response of capital goods producers to disequilibruim conditions requires considering affects of inventory and backlog conditions on output behavior.

Equation 1 generalizes the accelerator principle along these lines. Desired production of capital goods DPCG equals average sales of capital goods ASCG plus correction terms for output inventory and order backlog. When output inventory of capital goods OICG and backlog of orders for capital goods BOCG equal their desired levels, DPCG equals ASCG meaning that output is geared simply to meet average sales rate. Impact of inventory conditions is represented in Equation 1 as the inventory DICG minus OICG, divided by time to correct inventory of capital goods TCICG.

Low inventory necessitates production in excess of sales rate to rebuild inventory, while surplus inventory produces pressures to cut back output to liquidate inventory. Order backlog similarly affects desired production: high backlog necessitates production above average sales while low backlog indicates weak demand and contracts output. The backlog impact is measured by backlog of orders for capital goods BOCG minus desired backlog of capital goods DBCG divided by the time to correct backlog for capital goods TCBGC. Impact of inventories and backlogs on production is discussed in Mack (1967), Stanback (1961), and Zarnowitz (1961).

$$DPCG(t)=ASCG(t)+(DICG(t)-OICG(t))/TCICG + (BOCG(t)-DBCG(t))/TCBCG \quad (1)$$

To see how production policies for capital goods reinforce trends in capital investment, suppose that orders for capital are rising. Increased orders augment average sales, deplete output inventories of capital goods as those goods are shipped, and increase order backlogs for capital goods to the extent that appropriate output inventories are not immediately available. All three effects—higher sales, lower inventory, and increased backlog--raise desired production of capital goods DPCG. In turn, more production necessitates an increased capital stock. In Equation 2, desired capital in capital sector DKCS equals desired production of capital goods DPCG times the desired capital intensity in capital sector DCICS. DCICS measures the target capital-output ratio in the capital sector; its determinants are discussed in Section 2b. Finally, viewing order rate for capital as part of the stock adjustment process implies that

an increase in desired capital in capital sector will lead to still further orders for capital goods, further increase in desired production of capital goods, and so on.

DKCS(t)=DPCG(t)*DCICS(t)

Apart from current demand or supply conditions, as measured by output inventories, order backlogs, and average sale of capital goods, capital investment may also be affected by expectations of growth in sales. For example, suppose that demand for industrial equipment is growing at a rate of 3% per year. Then capital stock and other factors of production must be expanded at 3% per year to meet demand even if inventory and backlog are in balance at each point along the growth path.

Equation 3 integrates influences of both levels of demand and growth expectations on capital investment in capital sectors. Orders for capital in capital sector OCCS equal the sum of replacement orders for capital in capital sector ROCCS plus expansion orders for capital in capital sector EOCCS plus orders for supply line in capital sector OSLCS. The first term, ROCCS, represents orders to replace depreciating capital stock. OCCS would equal the replacement rate ROCCS if capital in the capital sector were at its desired level and if expectations of growth in sales were zero. The third term, OSLCS, is discussed later and represents orders for capital on the part of capital users to assure prompt deliveries and maintain an appropriate amount of capital on order.

The middle term in Equation 3, expansion orders EOCCS, is formulated in Equation 4 as the sum of two components. The first term is

equal to the desired additional number of capital units to be acquired (or disposed), equal to desired capital in capital sector DKCS minus capital in capital sector KCS, divided by the time to correct stock of capital in capital sector TCSCCS. The second term equals capital in capital sector KCS multiplied by the expected growth in sales in capital sector EGSCS. Since desired capital in capital sector DKCS depends on desired production of capital goods, it represents the influence on orders for capital of levels of demand in accordance with Equation 1. The second term in Equation 4 represents influence of growth or decline in demand for capital, apart from present levels for demand, on capital investment. Within Equation 3-4, then, rising orders for capital establish growth expectations that still further augment orders for capital.

$$OCCS(t) = ROCCS(t) + EOCCS(t) + OSLCS(t) \quad (3)$$

$$EOCCS(T) = ((DKCS(T) - KCS(T))/TCSCCS(T)) + KCS(t)\ EGSCS(t) \quad (4)$$

A third source of self-reinforcing growth in capital investment from real variables derives from long lead times during periods of physical capital shortage that encourage excelerating investment plans. Users of capital equipment try to maintain their outstanding orders for capital at an appropriate level to acquire that equipment at the rate required for their production plans. In terms of Equation 3, the desired rate of acquisition would be measured by the sum of replacement orders plus expansion orders for capital, that is (ROCCS + EOCCS). Orders for capital must be planned ahead by the lead time or delivery delay for capital goods. When lead times rise, capital goods must be ordered further ahead to

sustain the desired rate of acquisition over time. Thus in Equation 5 desired supply line in capital sector DSLCS equals desired rate of acquisition of new capital multiplied by the perceived delivery delay for capital PDDC. In turn, Equation 6 formalizes the supply line adjustment. Orders for supply line in capital sector OSLCS equal desired supply line in capital sector DSLCS minus supply line for capital in capital sector SLCCS, divided by the time to correct supply line in capital sector TCSLCS.

$$DSLCS(t) = (ROCCS(t) + EOCCS(t))\ PDDC(t) \qquad (5)$$

$$OSLCS(t) = (DSLCS(t) - SLCCS(t))/TCSLCS \qquad (6)$$

Delivery delay for capital tends to run high when backlog of orders for capital equipment BOCG is out of line with output inventory of capital goods OICG, the latter representing the physical output available to meet demands for capital goods. In Equation 7, delivery delay for capital DDC is therefore represented in symbolic form as an increasing function of the ratio of backlog to inventory BOCG/OICG.

$$DDC(t) = f(BOCG(t)/OICG(t)) \quad f'(\ ) > 0 \qquad (7)$$

In accordance with Equations 5-7, lead times for capital equipment can be seen to influence capital investment as follows: increased orders for capital goods fill order backlogs and deplete output inventories, thereby raising delivery delays for capital; in turn rising delivery delay triggers advance ordering of capital goods that further augments demand for capital.

II.B. Impacts of Shifting Relative Prices

Major capital investment booms are characterized not just by an increasing scale of production of capital goods, but by an increasing intensity of capital use in production. Figure 1 plots employment, real capital stock, and capital/labor ratio for the aggregate economy from 1925 to 1975. The figure shows a significant increase in capital/labor ratio in the late 1920's, and again following 1945.

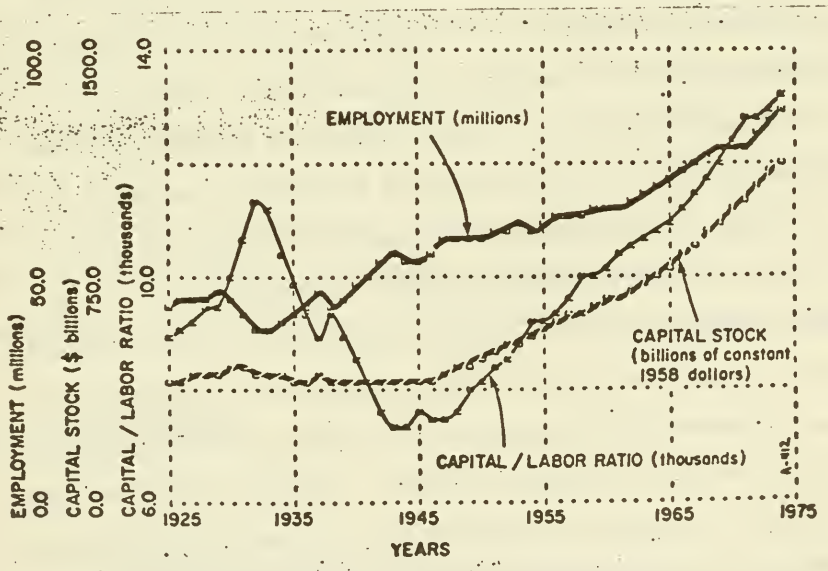

Figure 1
Aggregate employment and capital stock, 1925-1974.
Sources: Historical Statistics of the United States (pp. 126-127, 259) and Statistical Abstract of the United States (pp. 356, 429)

Sources of increasing capital intensity during capital investment booms can be explained in terms of the relative attractiveness of capital and labor as inputs to production. In Equation 8, desired capital intensity in capital sector DCICS equals capital-output ratio in capital sector CORCS multiplied by the perceived capital return to cost in capital sector PCRCCS. PCRCCS is lagged value of capital return to cost in capital sector CRCCS, which measures incentives for increasing capital intensity. In Equation 9, CRCCS equals price of capital goods PCG multiplied by the marginal product of capital in capital sector MPCCS, both divided by the marginal cost of capital in capital sector MCCCS. The numerator of Equation 9 measures the marginal revenue product of capital. The denominator represents the depreciation and interests costs of holding capital in inventory for a year. The ratio of marginal revenue product to marginal cost measures the incentive to increase capital relative to production. Thus in Equation 8, capital intensity is increased over the present capital/output ratio when the return to capital is perceived to exceed its costs, and conversely. The formulation in Equations 8-9 is similiar to impact of factor costs on capital investment in the neoclassical investment function (Jorgenson and Siebert (1968), Jorgenson, et al, 1970)), except that delays in perceiving marginal productivity of capital and in determining an optimal capital-output ratio are explicitly represented in the delay structure of PCRCCS. (Bischoff (1971) and Senge (1978) described the theoretical importance of distinguishing delays for adjusting capital intensity from delays for increasing capital stock to raise output at a given capital intensity.)

$$DCICS(t) = CORCS(t)\ PCRCCS(t) \quad (8)$$

$$CRCCS(t) = (PCG(t)\ MPCCS(t))/MCCCS(t) \quad (9)$$

During the initial phases of a capital investment boom, such as the period around 1940 in Figure 1, capital sectors are under pressure to expand output. Labor can normally be expanded faster than capital, which according to Keynes is produced through a relatively "roundabout" process of production. Rising labor relative to capital stock creates incentives for rising capital intensity that reinforces demand pressures for additional production of capital goods. Moreover, as shortages of labor develop, wage rates tend to rise. Increased wages create an additional incentive for more capital-intensive production by increasing capital return to cost in capital sector CRCCS. Thus, during an investment boom, capital sectors of the economy compete for labor against other producing sectors. The resulting shortage of labor and rising wages induce more capital-intensive production. Finally, more orders for capital further stimulate production of capital goods, thereby heightening the competition for labor between capital-producing and capital-using sectors.

II.C. Monetary Impacts

Monetary variables influence the pace of capital investment through two primary channels: the level of interest rates and the availability of money (or more broadly, liquidity) to support expenditures. A firm that is investing aggressively in capital equipment may frequently

run short of liquidity even though it is highly profitable, as measured by return on investment (Donaldson (1961, 1969)). Therefore, availability of external finance to supplement internal funds becomes a critical element in sustaining investment booms.

Equation 9 extends the previous formulation of orders for capital in capital sector OCCS to include liquidity pressures. Here, OCCS equals the sum of replacement orders ROCCS, expansion orders EOCCS, and orders for supply line OSLCS multiplied by the effect of liquidity on ordering in capital sector ELOCS. The term liquidity is used here broadly to comprise cash, short-term liquid assests (such as treasury bills or other marketable securities), and unused credit lines that could provide funds for investment. This definition of liquidity corresponds approximately to the broader definitions of money supply such as M_2 and M_3. ELOCS has a multiplicative influence in Equation 9 so that per cent changes in liquidity produce per cent changes in orders for capital goods (and at the extreme, zero liquidity implies zero capital investment).

ELOCS is a function of adequacy of liquidity--defined as the internal level of liquidity divided by the liquidity needed to support transactions. It has a normal value of 1 when the capital sector has adequate liquidity to sustain the pace of real activity. In Figure 2, ELOCS rises slightly above 1 in the face of more than adequate liquidity that would provide a slight incentive to increase aggressiveness of capital ordering. In this region, ELOCS is below the 45 line so that investment rises less than proportionately to liquidity when liquidity is high, or equivalently, the velocity of money falls. Friedman and Schwartz (1963a) document that velocity of money falls when money stock is high relative to

transactions. Moreover, Pesek (1976, 1977) shows that Irving Fisher's monetary theory incorporated a variable velocity depending on relative monetary stock and transactions, rather than a constant velocity as commonly interpreted (also see Mayer (1977). To the left of the (1,1) point in Figure 2, inadequate liquidity curtails capital investment. But here ELOCS is above the 45 line, so that producers try to maintain investment despite a shortage of liquidity and velocity of money rises (Friedman and Schwartz (1963a)).

Liquidity constraints must be incorporated in an investment function as in Equation 9 to isolate the role of real and monetary forces in generating investment booms and declines. Keynes (1937b) attributed a key role to availability of financial capital in the investment process, arguing, "It is to an important extent, the financial facilities that regulate the pace of new investment." Minsky (1975) similarly emphasizes that "the financial system....contains the potential for runaway expansion powered by an investment boom. This runaway expansion is brought to a halt because accumulated financial charges render the financial system fragile, so that not unusual changes can trigger serious financial difficulties." According to Minsky, "success breeds daring" in that incentives for profitable investment raise acceptable levels of debt in the eyes of both lenders and borrowers, until excessive debt charges eventually curtail expansion. Section III examines the behavioral effects of different regimes of tight or easy money towards sustaining investment booms and eventually turning those booms into declines. Coen (1971) and Sinai and Brimmer (1976) describe recent investment functions that incorporate liquidity constraints.

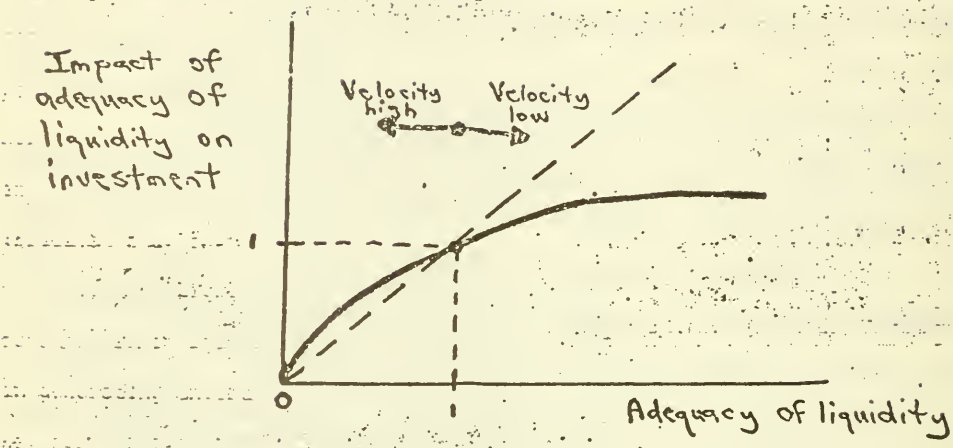

Figure 2

Impact of liquidity on investment

III. BEHAVIORAL IMPACTS OF MONETARY AND REAL VARIABLES.

The preceding hypotheses of the impacts of monetary and real variables on capital formation have been combined in a computer simulation model. The model consists of two production sectors: one producing consumer goods and the other capital goods. Each sector uses labor and capital as factors of production. Substitution between labor and capital in production is possible in accordance with a modified Cobb-Douglas production that allows for variable utilization of factors. Structure of the capital goods sector is based on Equations 1-9 above. Labor acquisition is assumed to depend on overall need for output in the capital goods sector and on relative profitability of labor intensive versus capital-intensive production; structure of labor acquisition is thereby parallel to that of capital investment. Similarly, equations for labor acquisition and capital investment in the consumer goods sector are structurally parallel to those for the capital goods sector.

A priori values for all model parameters were chosen to accord with values suggested by earlier corporate modeling studies with firms and goods and capital sectors (Mass (1975), Roberts (1978)). Least squares estimation was also used to estimate parameters. Estimated and a priori parameter values are generally quite close together, providing an important check on plausibility on model parameters. Senge (1978) reports estimations and statistical test results. Hypothesis tests support the structural hypothesis advanced earlier. For example, the results support the hypothesis that desired production rate is influenced not only by average sales as in the accelerator model, but also by relative inventory

and backlog conditions.

The following experiments attempt to gauge the relative importance of monetary and real variables. Impact of real variables on capital investment behavior can be isolated by neutralizing the monetary impacts. In all the experiments interest rates are held constant because the production sectors have not yet been integrated with a financial market model that would generate interest rates. However, different conditions of credit availability are examined to analyze their effect. Focusing on just money availability rather than on both money availability and interest rates does not fully exhaust analysis of monetary impacts. However, the analysis in terms of money availability should be indicative in the sense that tight money policies restrict investment both through high interest rates and through limited credit, so that both responses work in the same direction. The author is now working to extend the present analysis to incorporate variable interest rates. [De Leeuw and Kalchenbrenner (1969) discuss methodological limitations of single-equation models for isolating importance of monetary variables].

With the above provisos in mind, impact of real variables on investment is gauged by assuming that liquidity is always maintained at adequate levels. Under such conditions, liquidity has no effect on investment, providing neither incentive nor disincentive. With liquidity effects nuetralized, only real variables influence investment. Model simulations with liquidity neutralized can be compared with other simulations in which liquidity constraints are operative, to see the behavioral impact of those constraints. Similarly, different assumptions can be made about availability of money to the system to provide an

additional measure of sensitivity to monetary and real variables.

Figure 3 shows capital investment behavior when adequate liquidity is always maintained. Such a condition of adequate liquidity would correspond in real life to a highly accomodative policy by the Federal Reserve that injected money into the system to meet all transactions requirements and thereby eleminated the possibility of liquidity shortages. Specifically, Figure 3 shows the response of the consumer goods and capital goods sectors to a one time step increase in orders for consumer goods starting from equilibrium. In this model interest rates are held constant as noted earlier, and order rate for consumer goods is the exogenous input influencing behavior. Figure 3 shows fifty simulated years. From year 0 to 23 output of capital goods expands rapidly. At year 0 delivery delay for capital is slightly below its normal value of 1.5 years. Delivery delay rises up to a peak of over two years around year 17. The high delivery delay is symptomatic of rising orders for capital, depleting finished output inventories of capital goods, and rising order backlogs in capital sectors. Inadequate inventories of capital goods and high backlog fuel expansion of capital output, reinforcing expansion of capital sectors as long as the capital sector needs additional capacity to produce. Second, rising orders for capital create growth expectations that also augment demand for capital. Third, high delivery delay for capital during the build-up phase from years 0 to 23 encourage advance ordering of capital goods that sustains the imbalance between supply and demand that underlies the high delivery delay. Fourth, Figure 3 shows that labor in the capital sector expands more rapidly than the stock of capital in the capital sector during the production upswing;

expanded labor enhances marginal productivity of capital and favors more capital intensive production. Rising wages for labor (not shown in Figure 3) also foster more capital-intensive production.

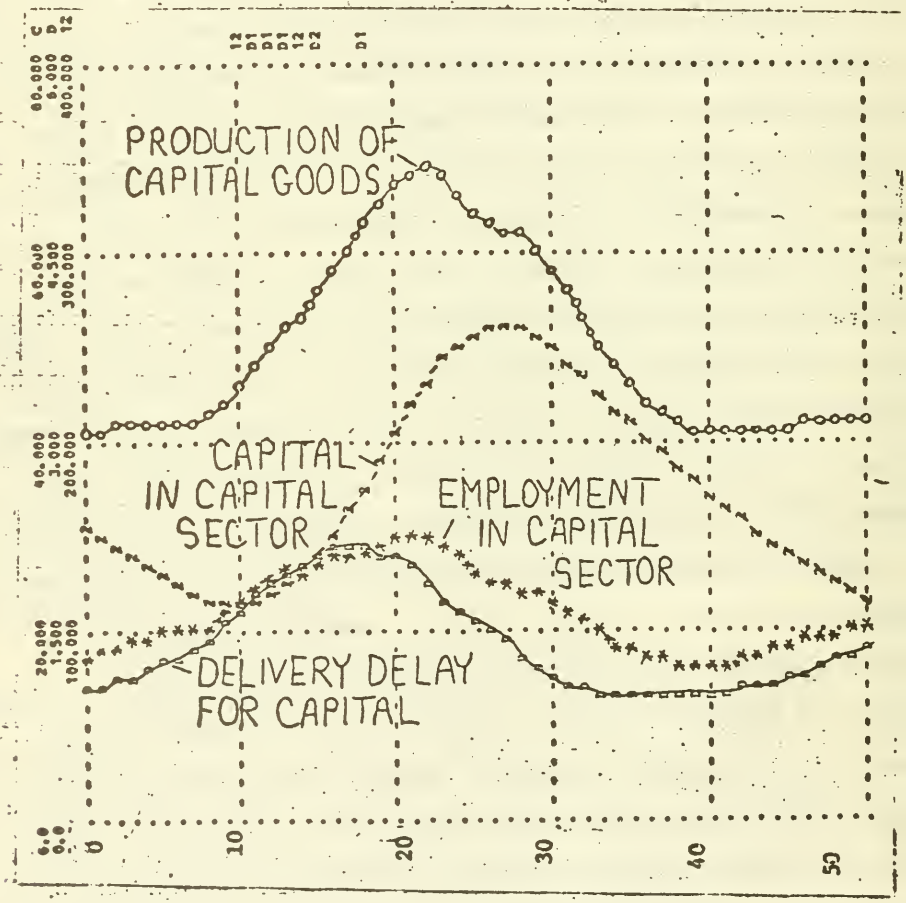

Figure 3

Investment behavior when adequate liquidity is maintained.

Production of capital goods expands by about 80% up to the

peak in Figure 3. The expansion is fueled by the cumulative forces described above and financed by the inflow of liquidity to meet the rising level of internal activity. As long as liquidity is held adequate, the real forces and shifts in relative prices promote a self re-enforcing upturn. Thus the behavior in Figure 3 from year 0 to 23 shows a sustained investment boom. The behavior is consistent with the observation of Friedman and Schwartz that expanding income and investment go hand and hand with increasing money supply. It is also consistent with Minsky's observation that sustained investment booms are accompanied by credit expansion motivated by a growing dependence of firms on external finance. For example, Minsky (1974) notes that ratio of corporate debt to profits before taxes more than doubled during the investment boom of 1950's and early 60's. However, the behavior in Figure 3 provides some important perspectives on the role of money in generating investment booms. First, throughout the simulation, adequacy of money is maintained so that money has a consistently neutral effect on investment plans. Therefore, it cannot be properly said that monetary expansion is driving the investment boom, so much as the expansion of money is allowing non-monetary forces to take root and trigger the investment boom. Therefore, the model underlying Figure 3 isolates real forces and shifts in relative prices and wages that can sustain a prolonged investment boom. Simultaneous expansion of income and money supply (liquidity) in Figure 3 occurs not because money is driving the expansion but because growing liquidity requirements lead to credit expansion. But money does have an important role in the system of Figure 3, as seen in more detail later, for it is the sustained availability of money throughout the investment expansion period that

allows that expansion to generate such momentum and continue for such duration.

Capital production eventually overexpands in Figure 3. Delivery delay in the capital sector peaks at about year 17, ahead of the peak in production which occurs at about year 23. Delivery delay in capital sector is highest when the imbalance between supply and demand for capital goods is greatest. Therefore delivery delay tends to peak when pressures for expansion of capital output are the highest. By the peak of production, delivery delay has almost fallen back to its normal value. However, restoring delivery delay to a normal level requires producing for a period of time in excess of orders, both to reduce order backlog and thereby alleviate excess demand and to build up output inventory and thereby increase available supply of capital goods. Therefore, once delivery delay has been restored to normal, production of capital goods exceeds the output rate needed to sustain the existing capital stock against depreciation. Overcapacity develops. At this point, all of the mechanisms that previously sustained build-up of capital production now reverse their effect to accelerate decline in capital formation. For example, as order backlog for capital goods falls and output inventory overbuilds, desired production of capital goods declines, thereby lowering desired capital in capital sector and further decreasing orders. Moreover, falling delivery delay means that advance ordering is no longer necessary, so orders for supply line wane. Analogously, each of the mechanisms that encourages capital production when capacity is short of demand acts to depress new orders for capital goods once capacity comes to exceed orders.

Figure 3 thus shows a strong tendency for long investment booms to

eventually turn themselves into declines. The behavior provides an interesting perspective on the monetarist position that major economic downturns are occasioned by monetary contraction. In Figure 3, money has a neutral effect. On the downturn, investment, income, and money stock would fall concomitantly, as occurred during the Great Depression of the 1930's (Friedman and Schwartz, 1963a). But as on the upturn, money is not driving the changes in income. Instead, the causality is reversed: falling investment and income reduce liquidity requirements and thereby lower the stock of money through diminished demand for credit. This behavior is consistent with the analysis in Temin (1974, 1976) of the Friedman-Schwartz explanation of the Great Depression. Temin observes that Friedman & Schwartz (1963a) "looks only at one side of the market and ignores effects coming from the demand for money... Friedman and Schwartz held the Fed responsible for the decline in the stock of money after the crash...[But] the fall in income may have decreased the demand for money leading to lower interest rates and therefore smaller borrowing from the Fed. In other words, the decline in the stock of money may have been a result of the fall in income." Temin thus argues that the stock of money is determined not by the supply considerations alone, but also by the demand for money and liquidity.

The behavior in Figure 3 also provides some perspectives on the accelerator theory of investment. The accelerator theory sees changes in final demand (consumption) as the driving force underlying booms. But in Figure 3, the investment upsurge is not driven by consumption, which is held constant exogenously, but by the internal dynamics of investment decisions within the capital sectors and by the coupling between capital

and good sectors through the effect of delivery delay for capital on ordering. Although the accelerator theory is frequently held to be an outgrowth of Keynes, the emphasis on consumption as the driving force for income is in fact inconsistent with Keyne's stated thrust. In his 1937 response to Viner, Keynes summarizes the General Theory as follows:

> The theory can be summed up by saying that given the psychology of the public, the level of output and employment as a whole depends on the amount of investment. I've put it this way, not because this is the only factor on which agregate output depends, but because it is usual in a complex system to regard as the causa causans that factor which is most subject to wide fluctuations.

As described in Minsky (1975), Keynes thus saw the investment function, rather than the consumption function, as the fundamental determinant of income.

The behavior in Figure 3 thus identifies a variety of non-monetary forces that can account both for the periodic existence of sustained investment booms and also for the tendency for those booms to turn into decline. As such, the behavior points to a more prominent role for non-monetary variables than attributed in the monetarist theory.

Figure 4 shows an additional simulation in which the assumption of continuously adequate liquidity in the consumer goods capital sectors is relaxed. Here, money supply in the system is assumed to be fixed. In other words, a fixed amount of money is assumed to circulate between consumer goods, capital goods, and household sectors with no accomodation by the Federal Reserve to apparently growing liquidity requirements by increasing money supply. As in Figure 3, the household component of the system is highly simplified: household consumption depends

on an exogenously fixed normal level of demand modulated by adequacy of liquidity in the household. Household liquidity is augmented by wages and dividends paid by the consumer goods and capital goods sectors and decreased by spending for consumer goods. The effect of household liquidity on consumption proxies the standard concept that consumption depends on income or on assets.

Figure 4 shows fifty simulated years starting from about the same initial conditions as in Figure 3, at the start of an investment upturn. However, the behavior in Figure 4 differs importantly in magnitude from that in Figure 3. The investment upturn in Figure 4 starts around year seven or eight and peaks before year twenty. Moreover, production of capital goods rises by less than fifty percent from trough to peak as compared with the almost eighty percent expansion in Figure 3. Figures 4 and 3 differ only in that adequacy of liquidity which was held normal in Figure 3 is now free to fluctuate in accordance with money levels and target expenditures in each of the sectors. The same real variables and shifts in relative prices that fueled the investment upturn in Figure 3 also account for the upsurge in Figure 4. But Figure 4 shows that with a fixed money supply circulating between production and household sectors of the economy, investment plans come to be restricted by inadequate liquidity. Adequacy of liquidity is high at year 10, as measured by a value above one. After year 10, pressures to expand production of capital goods create mounting liquidity requirements in the capital sector to meet wage payments and finance capital expenditures. But with a fixed amount of total money in the system, the sector begins to encounter liquidity shortages. Inadequate liquidity thus begins to force curtailment of

investment plans and throttles the non-monetary forces evidenced more potently in Figure 3. Liquidity constraints thus account for both the shorter duration and the diminished magnitude of the investment upsurge in Figure 4 as compared with Figure 3.

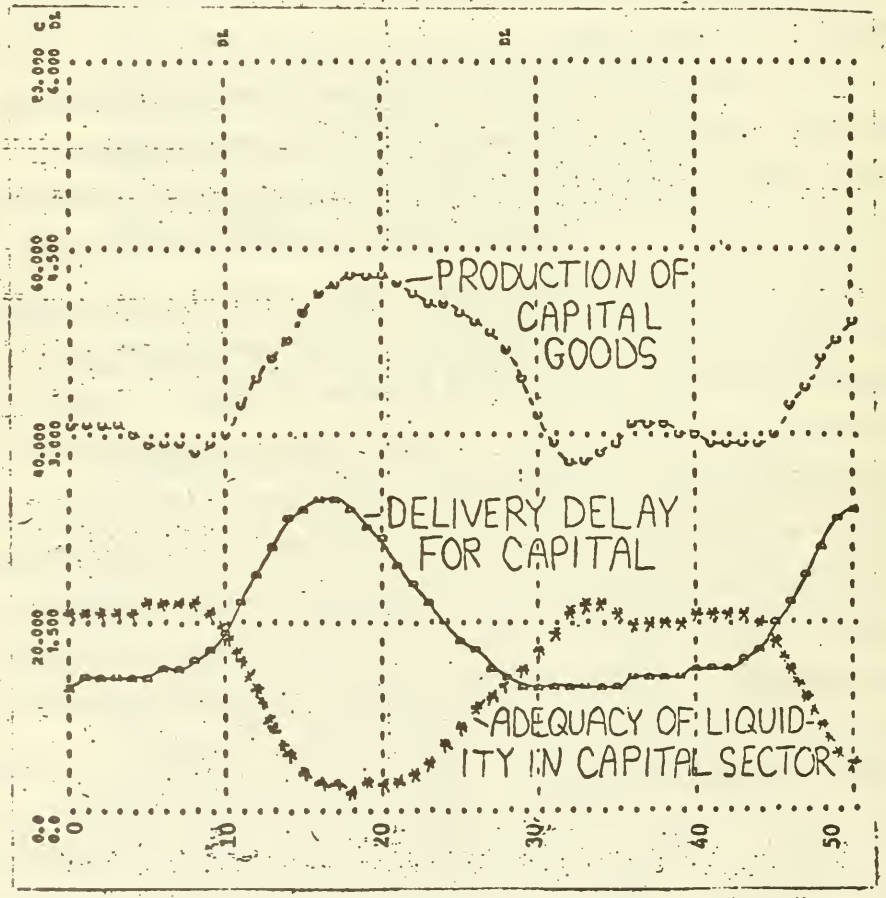

Figure 4

Investment behavior with fixed money supply

The assumption of a fixed money supply in Figure 4 is unrealistic in the sense that it has not been observed historically. But the conditions of Figure 4 do serve as an effective contrast with the assumptions of Figure 3. In Figure 3, a highly accommodative Federal Reserve always maintained adequate liquidity through monetary expansion despite rapidly growing liquidity needs. At the other extreme, in Figure 4, the Federal Reserve is completely unresponsive, and fails to foster monetary expansion even in the face of growing economic activity. Comparison of Figures 3 and 4 thus provides an effective basis for isolating the impact of money supply on investment behavior.

In Figure 4, an investment boom does take place, albeit of lower magnitude than in Figure 3. Demands for increased production of capital goods trigger the expansion despite the fixed money supply. Figure 4 thus exhibits an increasing velocity of money during the upturn, as firms in the consumer goods and capital sectors economize on cash balances and continue to invest because of output pressures, despite inadequate liquidity. The increasing velocity of money during the upturn in Figure 4, and declining velocity during the downturn are consistent with evidence in Friedman and Schwartz (1963a). For example, Friedman and Schwartz note that velocity of money declined by about twenty per cent during the Great Depression. In terms of Figure 4, velocity of money declines during a period of over-expanded investment because diminished investment incentives curtail expenditures even in the face of adequate money. The behavior in Figure 4 is thus consistent with Temin's argument that production and money supply during the 1930's may have been driven by falling income, rather than the reverse.

The behavior in Figures 3 and 4 points to an important role of money supply in investment booms and declines. Figure 4 shows that if money supply is not expanded to meet transactions requirements, an investment boom may be sharply curtailed. However, as seen in Figure 3, the expansion of money still cannot be said to be the fundamental driving force in creating the boom; nor is contraction of money the fundamental source of the decline. However, a proper conclusion, consistent with Minsky, would be that expansion of money is needed during an investment boom to accommodate growing transactions and thereby sustain expansion. For example, Minsky (1975), notes that the investment boom of the 1950's and 1960's was fostered by "the inventiveness of the financial system in discovering ways to accommodate the demand for finance..." From this perspective, monetary expansion by the Federal Reserve and liability management by banks to increase money supply during the 1950's and 1960's provided an indispensible financial base that prevented early aborting of the investment expansion. Note that Figures 3 and 4 show that monetary policies may thereby have a strong effect on the economy during periods in which production sectors are strongly dependent upon external finance. In contrast, Mass (1978) shows that once capital investment overexpands and producers have diminished incentive to invest in new capacity, reduced dependence on external funds may imply low leverage for even highly expansive monetary policy to sustain the investment boom. This behavior is consistent with the idea of the Keynesian liquidity trap.

IV. CONCLUSIONS

This paper has attempted a first integration of monetary theories and accelerator (spending) theories of investment booms and declines. In the literature, the two schools of thought are divergent and competing. However, the preceeding analysis shows that investment booms and declines are characterized by a close interaction between real and monetary forces that gives them their character. In fact, both schools of thought appear to have a valid side of the story to tell, but neither side tells the whole story.

The accelerator and spending theories emphasize real variables and interest rates as determinants of investment. But they admit no influence of liquidity conditions on expenditures. Moreover, they tend to see final demand as the active driving force in the economy. In this spirit, Temin (1976) concludes that the Great Depression occured due to an autonomous decline in consumption expenditures. But Temin's conclusions, like the thrust of the accelerator theories, ignores the array of powerful non-monetary forces seen in Figures 3 and 4 that can drive long booms and declines from capital investment dynamics.

The monetary theories importantly stress effects of money stock on transactions. Through influencing money supply, Federal Reserve policy can be a key ingredient in sustaining investment booms, as seen in Figures 3 and 4. However, the monetarist theories give short shrift to real economic forces and may thereby overstate the role of money as the active agent in producing booms and decline. The results presented earlier

would support the interpretation that money is important as a component of liquidity necessary to support a boom, but that non-monetary forces exert a key role in generating the "animal spirts" that trigger the boom. Similarly, monetary contraction may be more a symptom than a prime cause of investment declines. Finally, monetary policy may exert high leverage when liquidity shortages prevail, but low leverage when excess capacity encourages rebuilding liquidity rather than investing in capital goods.

These conclusions point to an explanation of investment booms and declines that draws pieces from both monetarist and accelerator schools, but which essentially lies between them. An important focus for future work is to integrate this analysis with a model of markets for financial capital and interest-rate setting. An integrated model could explore additional channels of real-financial interaction, including rising credit limits in the face of sustained growth in sales, and variable risk premiums for capital investment depending on memory of past liquidity crises. Such analysis may contribute to a less "partisan" view of the economy in which money and real variables both have a place, and thus to an improved framework for assessing economic policies.

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